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Aspen Regeneration in 6- to 10-year-old Clearcuts in Southwestern Colorado

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Aspen regeneration in 6- to 10-year-old clearcut blocks was substantially less than these values from the same blocks at ages 1 to 5 years. Damage from disease and other environmental factors has reduced the numbers and distribution of sprouts to levels that preclude successful restocking of several of the blocks studied.

Keywords: *Populus tremuloides*, clearcutting, regeneration, mortality.

Introduction

Aspen (*Populus tremuloides*) grows on millions of acres throughout the central Rocky Mountains (Jones et al. 1985). Much of this aspen is in relatively pure stands of commercial quality and is accessible for harvest. Aspen on the remaining acres has little economic value at present, but still provides habitat for many wildlife species, as well as forage for livestock, firewood, and scenery. Most of this aspen in the Rocky Mountains is more than 70 years old and considered to be in mature and overmature age classes.[2]

One of the few stable markets in this region for aspen is in southwestern Colorado, where aspen stumpage has been sold regularly for more than 30 years. Data for this study were obtained from a timber sale in the early 1970s, which clearcut more than 60 blocks ranging in size from 2 to 20 acres. Response of understory vegetation, including aspen regeneration during the first 5 postlogging years, was reported in earlier publications (Crouch 1983a, 1983b). This note describes further responses of aspen regeneration to the clearcutting when the original 1- to 5-year-old clearcuts were 6 to 10 years old (figs. 1 and 2).

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[2]*Unpublished data collected by Wayne D. Shepperd, on file at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.*

Study Area

Because the study area was described in detail in the earlier publications, its characteristics are only briefly reviewed here. The study site is on the San Juan National Forest, about 25 miles northeast of Dolores, Colo. Elevations range from 9,000 to 9,500 feet on relatively gentle topography. Aspen grow there in large, multi-clonal stands of trees up to 25 inches d.b.h. and 90 feet in height. Understory vegetation mostly resembles the *Populus tremuloides/Symphoricarpos oreophilus* and *Populus tremuloides/Thalictrum fendleri* habitats described by Hoffman and Alexander (1980, 1983) in northwestern and west-central Colorado. About 600 acres, or 25%, of the sale area, was clearcut.

Methods

Data originally were collected from 15 clearcut blocks, distributed over about 60% of the sale area. Among these, three blocks were selected from each year of logging, from 1974 through 1978. Within each year class, one block was selected from each of the following size classes: 3–7, 8–12, and 13–17 acres. All blocks were rectangular. One additional block corresponding to each clearcut size class was established in uncut aspen as a control. The 15 clearcut blocks plus 3 controls comprised the original sampling sites. Only clearcut blocks were reinventoried in 1984.

In 1979, aspen regeneration was inventoried on one-half-milacre, circular plots spaced 55 feet apart on two sampling lines located equidistant from the block edges and from each other. Data were thus obtained from 14, 20, and 24 plots on the small, intermediate, and large blocks, respectively.

These same plots were relocated in 1984, and aspen regeneration was reinventoried in September of that year on milacre plots, instead of the one-half-milacre plots used in 1979. The larger plots were designed to provide more practical stocking data from the older clearcuts.

Data Analysis

Comparisons among clearcut ages and sizes were conducted using 2-way analyses of variance ($P = 0.10$), and means were separated according to Tukey (Snedecor 1961). Statements such as increase, decrease, greater or lesser, etc., indicate that differences described are significant ($P = 0.10$).

Results

Details on overstory characteristics obtained from uncut blocks were reported in Crouch (1983a). Briefly, aspen averaged 198 square feet of basal area distributed on 650 stems per acre. The stands were virtually intact, although dominants averaged more than 120 years old.

Figure 1.—Aspen clearcut 1 year after logging—28,400 sprouts per acre, averaging 2 feet in height.

Figure 2.—Aspen clearcut 5 years after logging—9,200 sprouts per acre, averaging 6 feet in height.

Numbers of Sprouts

In 1979, numbers of sprouts on first- and second-year clearcuts averaged more than 30,000 per acre, and stocking in one-half-milacre plots averaged 93%. Size class of clearcut had no effect on any measured attribute. Nearly all sprouts present were produced in the first year after logging.

Numbers of sprouts declined rapidly during the first 5-year segment and continued to decline during the second 5 years (table 1). Among all blocks, mortality averaged 79 ± 8% of sprouts alive in 1979. Losses were greatest in smaller and lowest in larger blocks.

Precipitous declines such as these appear to be common after clearcutting in many aspen stands and may be required to ultimately result in the 650 trees per acre found in the uncut stands.

In 1984, numbers of sprouts ranged from 10,035 per acre in the smallest 6-year-old block to 215 per acre in the small 10-year-old clearcut (table 1).

Stocking

Stocking percentages based on plots occupied by at least one live sprout were highly variable among year and size classes, ranging from 86% in the smallest 6-year block to 14% in the smallest 10-year clearcut (table 1).

Based on subjective selection of potential crop trees, stocking in 1979 in one-half-milacre plots had declined to less than 50% in the 1- to 5-year blocks. In 1984, crop tree standards were relaxed somewhat, because by then, the observer had gained considerable experience in differentiating between sprouts which were likely to survive and grow well and those that would die. Despite the use of milacre plots and less strict standards of sprout quality, the percentages of crop tree stocking averaged only 54% at 10 years. Using 70% as an arbitrary rate for satisfactory stocking, only 5 of the 15 clearcut blocks of all age classes met the criterion. Stocking with potential crop trees ranged from 86% in the small 6-year block to 7% in the smallest 10-year block. Among all blocks, total and crop tree stocking were higher in larger and lower in smaller-sized blocks.

Tree Heights

Heights of trees based on the tallest stem in a milacre plot are shown in table 1. Average tree heights were consistently greater each year after logging, although they were highly variable between blocks within the same year class. The tallest trees, averaging 17.2 feet, were measured in the largest 10-year block, and the shortest, 5.7 feet, in the intermediate 6-year block. Among size classes, trees were taller in the larger clearcuts and shorter in the smaller blocks.

Table 1.—Characteristics of aspen sprouts on 6- to 10-year-old clearcuts on Stoner Mesa, southwestern Colorado.[1]

Characteristic and block size (acres)	Years after clearcutting					
	6	7	8	9	10	Mean ± SE
Number per acre						
Small (3-7)	10,035	2,500	1,715	2,500	215	3,393 ± 1,164b
Medium (8-12)	3,545	4,210	6,300	3,050	3,700	4,161 ± 531ab
Large (13-17)	8,300	9,300	5,290	3,500	3,875	6,050 ± 1,430a
Mean ± SE	7,293 ± 1,663a	5,336 ± 1,552a	4,435 ± 952ab	3,017 ± 398b	2,597 ± 776b	
Damaged by snow (percent)						
Small	32	51	38	27	75	45 ± 8a
Medium	32	42	28	44	14	32 ± 4ab
Large	35	19	37	28	9	26 ± 4b
Mean ± SE	33 ± 3a	37 ± 7a	34 ± 6a	33 ± 8a	33 ± 15a	
Damaged by voles (percent)						
Small	11	15	8	7	0	8 ± 3a
Medium	4	6	14	0	9	7 ± 2a
Large	8	2	4	10	9	7 ± 2a
Mean ± SE	8 ± 2a	8 ± 4a	9 ± 2a	6 ± 2a	6 ± 2a	
Stocking, total (percent)[2]						
Small	86	64	36	57	14	51 ± 9b
Medium	50	84	75	70	80	72 ± 5a
Large	65	80	75	54	75	70 ± 6a
Mean ± E	67 ± 10a	76 ± 7a	62 ± 10a	60 ± 7a	56 ± 14a	
Stocking, crop trees (percent)[2]						
Small	86	64	36	50	7	49 ± 9b
Medium	46	67	75	60	80	65 ± 7ab
Large	65	80	67	50	75	67 ± 6a
Mean ± SE	66 ± 11a	70 ± 8a	59 ± 9a	53 ± 4a	54 ± 15a	
Heights (feet)[3]						
Small	5.9	7.6	7.7	12.2	6.1	7.9 ± 0.9b
Medium	5.7	6.3	10.4	8.7	13.1	8.8 ± 0.9ab
Large	8.9	13.1	10.8	8.0	17.2	11.6 ± 1.2a
Mean ± SE	6.8 ± 0.7c	9.0 ± 1.5b	9.6 ± 0.8b	9.6 ± 0.9b	12.1 ± 2.1a	

[1]*Within characteristics, means within years or size classes followed by the same letter are not significantly different (P = 0.10).*
[2]*Circular milacre plots containing one or more sprouts.*
[3]*Height of the tallest sprout in each sampling plot.*

Snow Damage

Damage to aspen sprouts by snow was described and discussed in a previous publication (Crouch 1983a). This phenomenon was investigated further. Observations in March 1983 and 1984 showed that virtually all sprouts in most of the younger clearcut blocks were bent over and buried by snow (fig. 3). The attendant physical, bending stress is probably responsible for the basal compression injuries described earlier (Crouch 1983a).

Incidence of snow damage indicated by main stem compression injuries and severe branch stripping on trees up to 15 feet in height inventoried in 1984, is shown in table 1. Incidence was higher in the smaller, and lower in the intermediate and larger blocks, although it was highly variable among year classes.

Damage by Voles

Barking by voles (*Microtus* sp.) not observed in 1979, was amply evident in 1984. Although not severe, damage was widespread (table 1). All sprouts on which damage was recorded were completely girdled and were expected to die. Damage by voles is periodic, depending on numbers of animals whose populations are periodic or cyclic. Size class of clearcut was unrelated to damage by voles.

Discussion

Numbers of trees and stocking percentages greatly declined between 1979 and 1984. Some clearcut blocks were not successfully regenerated, and others were rapidly losing numbers and stocking of sprouts. Negative factors such as snow damage, evident in 1979, were still operating in 1984, although damage by cattle did not appear to materially affect regeneration success in the second 5-year segment. Total numbers of sprouts, stocking, and tree heights were greater in larger blocks, and snow damage was lower in those classes suggesting that, perhaps, larger block sizes might ameliorate possible adverse effects of snow.

However, a new, unidentified mortality factor was observed in 7 of the 15 study blocks. During the growing

season, affected sprouts initially appeared to be under moisture stress. Leaves began to change color and wither. Soon, stems turned dark brown or black, beginning at the terminal and progressing to the roots. Scraping of the bark revealed discolored tissue and a cinnamon-like odor. All sprouts that exhibited these symptoms died. Mortality of both vigorous and poor quality sprouts was observed.

The result of this phenomenon was complete mortality of sprouts over substantial areas of the affected blocks (fig. 4). This factor was associated with 90% mortality in the smallest 10-year block and the loss of all sprouts on nearly one-half of the intermediate 6-year block.

The agent or event responsible for the mortality is unidentified, although similar regeneration failures have been observed where clearcutting aspen overstories apparently has raised water tables, causing sprouting failure or subsequent sprout mortality. Based on data from a weather station 10 miles away, precipitation in both winter and summer during 1982–1984 was considerably above normal on the study area, and many clearcut blocks contained standing water or muddy areas throughout the growing seasons. Because the damage often appeared to be associated with wet areas, and those occupied by plant species such as *Veratrum tenuipetalum* and *Heracleum sphondylium* that grow on wet sites, the problem may be related to high water tables or other atmospheric-physiological processes associated with excess moisture.

Figure 3.—Aspen clearcut 5 years after logging. The 5,700 sprouts per acre are bent and buried by 4 to 5 feet of snow.

Figure 4.—Nearly complete mortality of aspen sprouts at 10 years on the clearcut shown in figure 2.

After 6 to 10 years, successful restocking of the study area is questionable. Long-term rates of decline in numbers of sprouts and stocking rates after clearcutting have not been determined in southwestern Colorado, because aspen has only recently been clearcut.

The stands that are now being logged resulted from some natural force, possibly fire, which produced regeneration conditions far different from those resulting from clearcutting. In the future, however, clearcutting may be an increasingly important part of the management of aspen. Therefore, the unknown mortality factors described here need to be identified and ameliorated to assure that the logged stands successfully regenerate.

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